

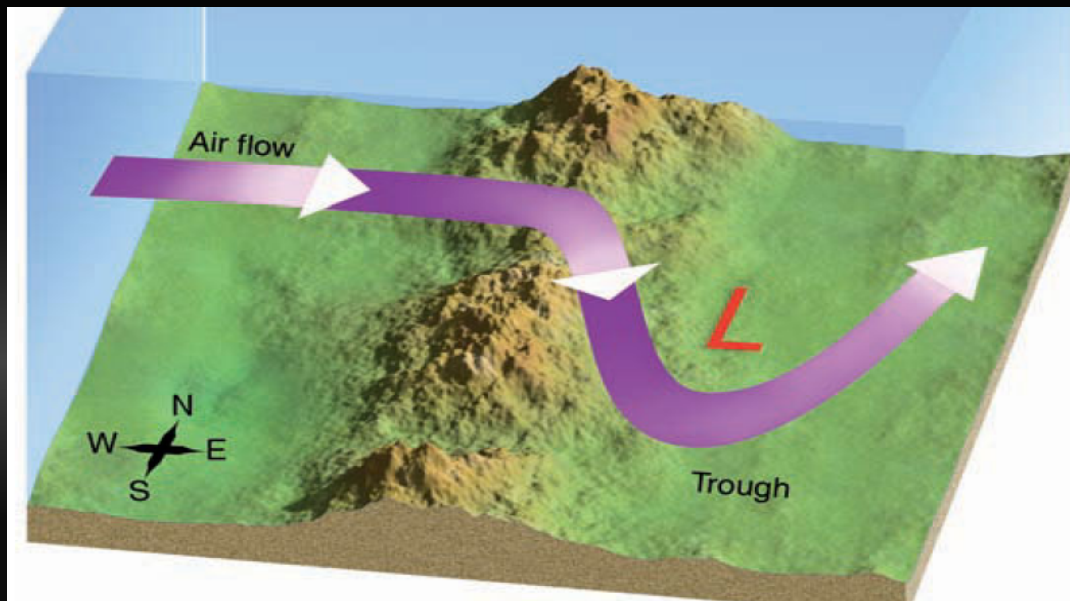
Stratospheric intrusion-influenced ozone air quality exceedences investigated in MERRA-2

K. Emma Knowland
USRA/GESTAR, NASA/GMAO

In collaboration with:
Lesley Ott, NASA/GMAO
Bryan Duncan, NASA/GSFC
Kris Wargan, NASA/GMAO, SSAI

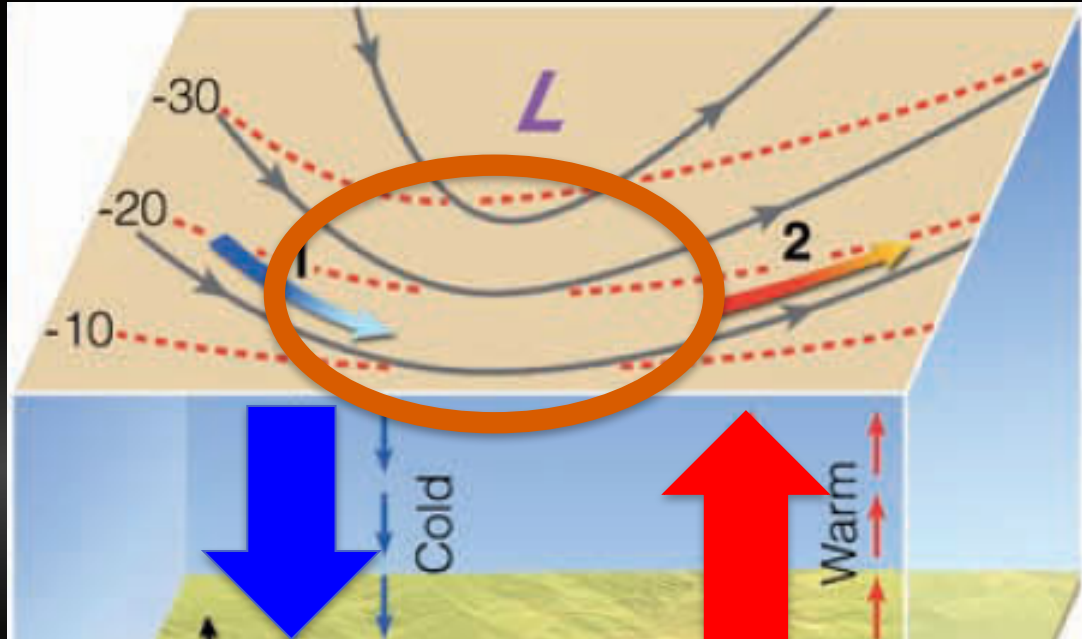


Introduction to upper-level features



Upper-level wave trains exist, with troughs often forming as the flow is disturbed by mountains

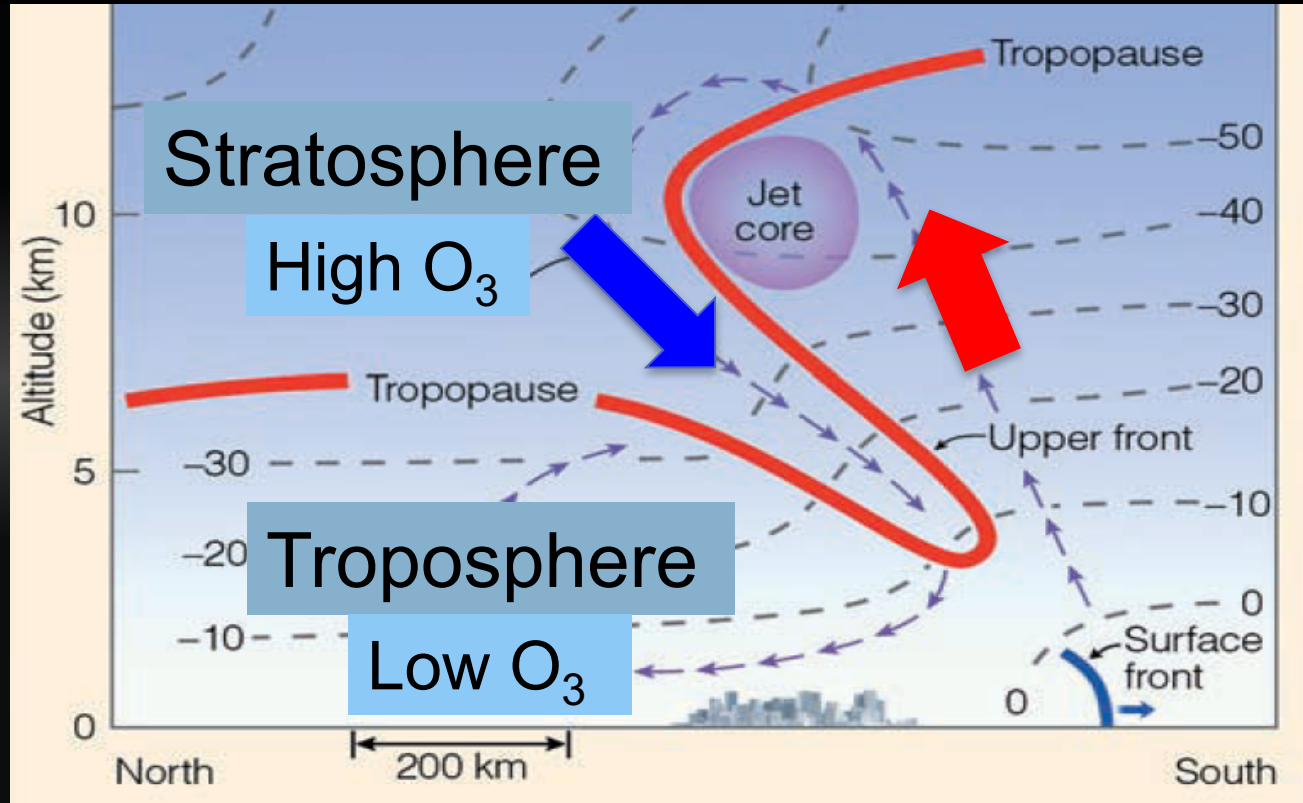
- Converging air accumulates and **subsides**
- Diverging air draws air **upwards** from the surface
- As air enters the trough, wind speeds increase resulting in a jet maximum at the trough base.



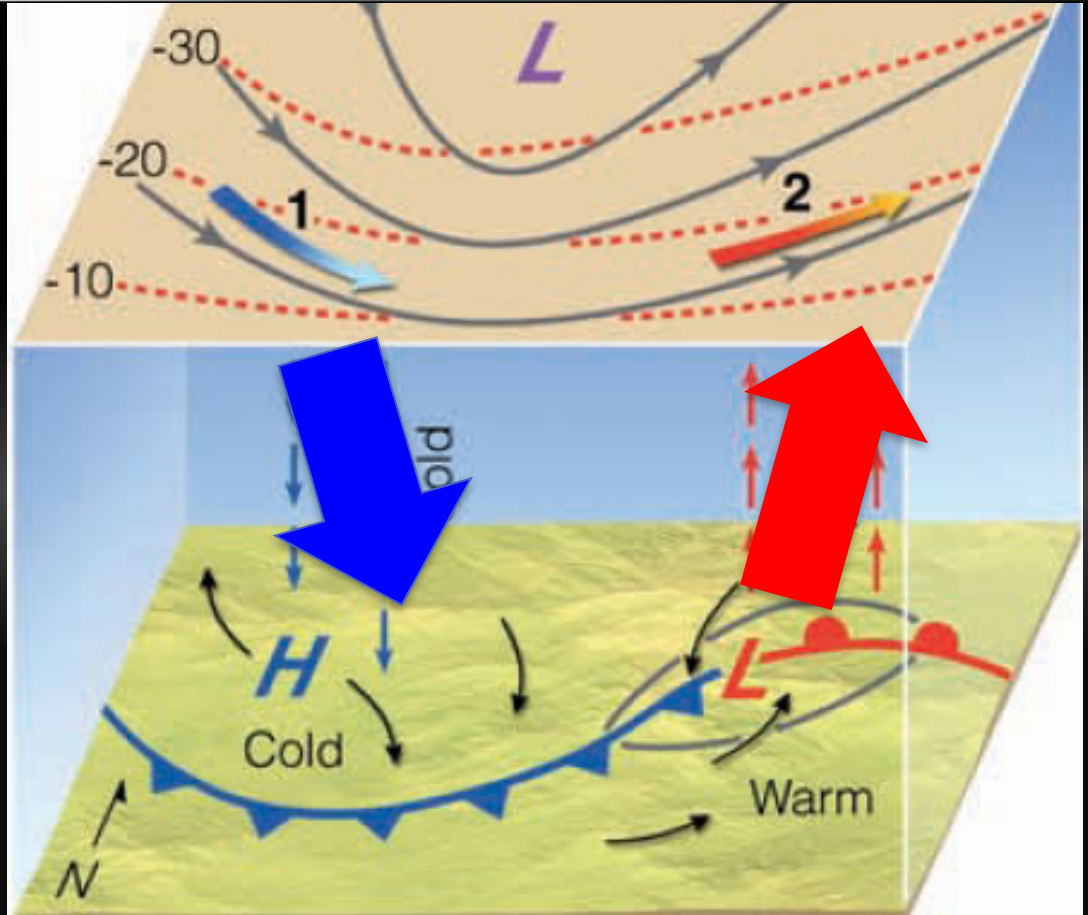
Tropopause Fold (Stratospheric Intrusions: SI)

SIs are associated with:

- High O_3 , PV
- Low CO , moisture (“dry intrusion”)



- upper-level trough supports development of a mid-latitude cyclone
- SI descends behind cold front



- Impact of SIs on surface O_3 is well documented
- Resolution of current global meteorological (re)-analyses are able to resolve SIs
- Simulating and predicting such events remains challenging
- Very few studies of SIs use reanalysis O_3

O₃ is a regulated air pollutant

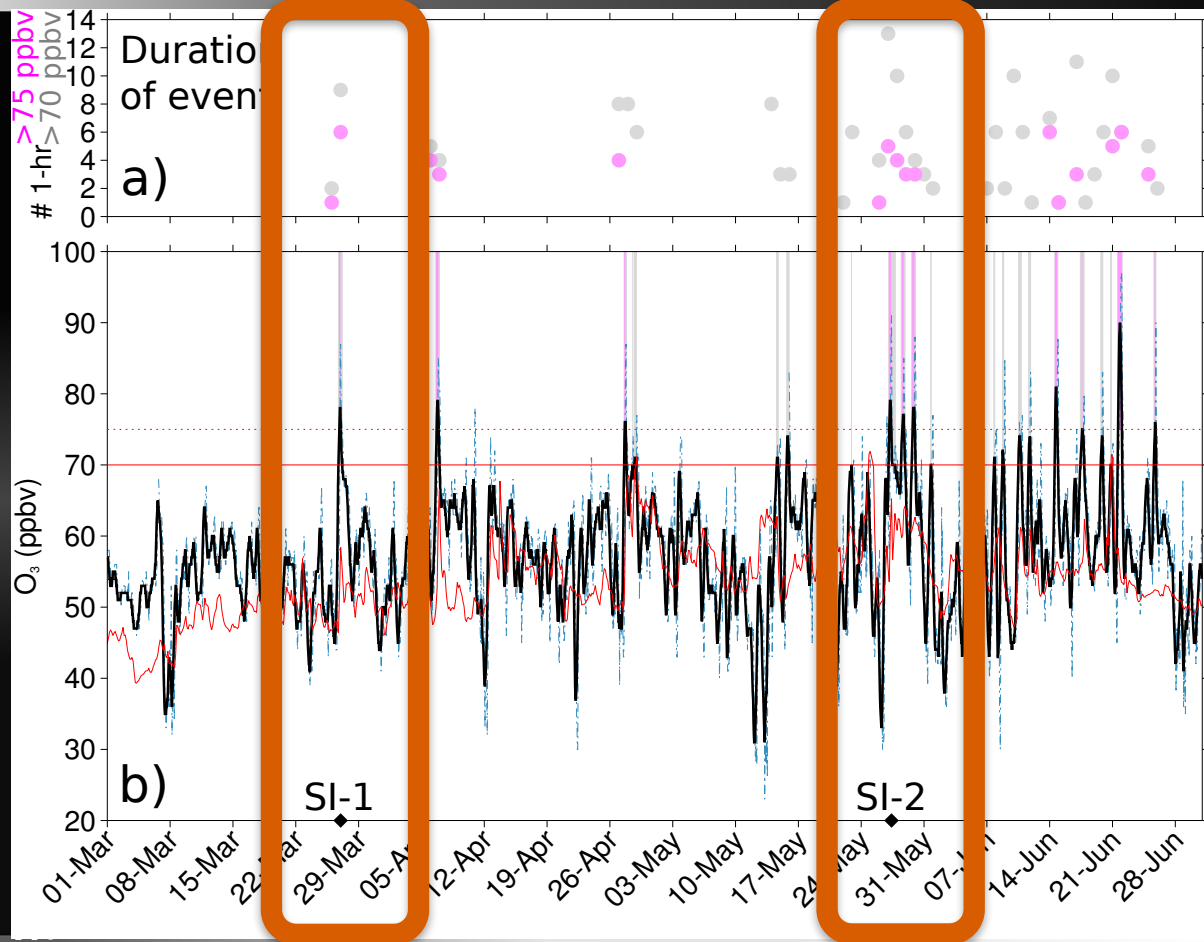
- SIs can lead to concentrations of ground-level O₃ exceeding the national ambient air quality standard (NAAQS) set by the EPA, especially at high elevations
- In October 2015, the EPA revised the U.S. NAAQS for daily maximum 8 h average (MDA8) O₃ from 75 parts per billion by volume (ppbv) to 70 ppbv

Question

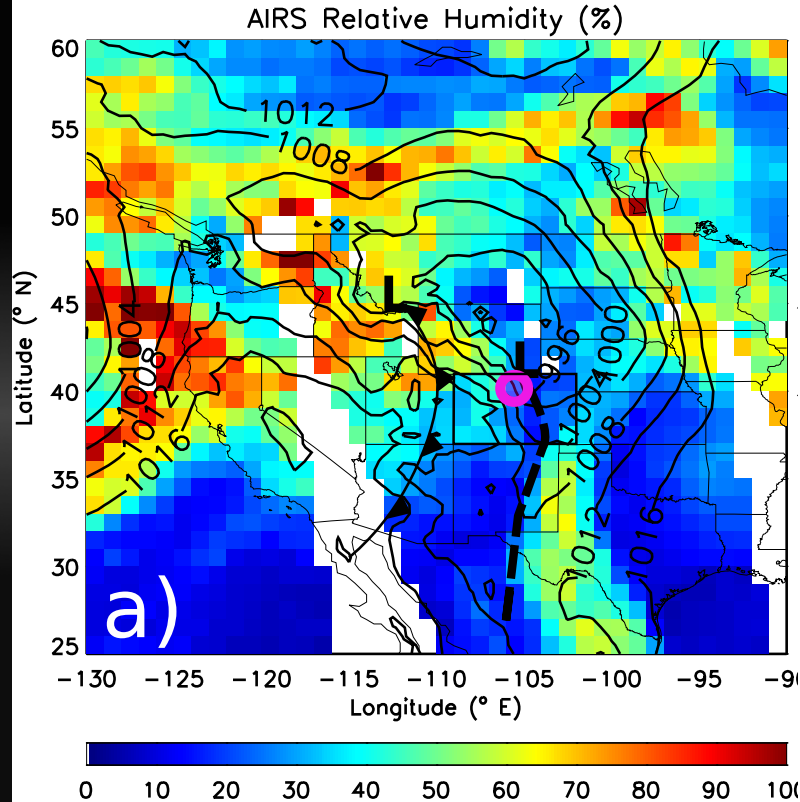
- Can MERRA-2 capture the dynamical features of a stratospheric intrusions?
 - in particular, the isentropic descent of elevated O_3 within and below the tropopause fold?

- 5 SI-exceedence events at RMNP, CO MAM 2012
- MERRA-2 O_3 underestimates surface O_3 variability but still spikes near times of SIs

Knowland et al., 2017, GRL



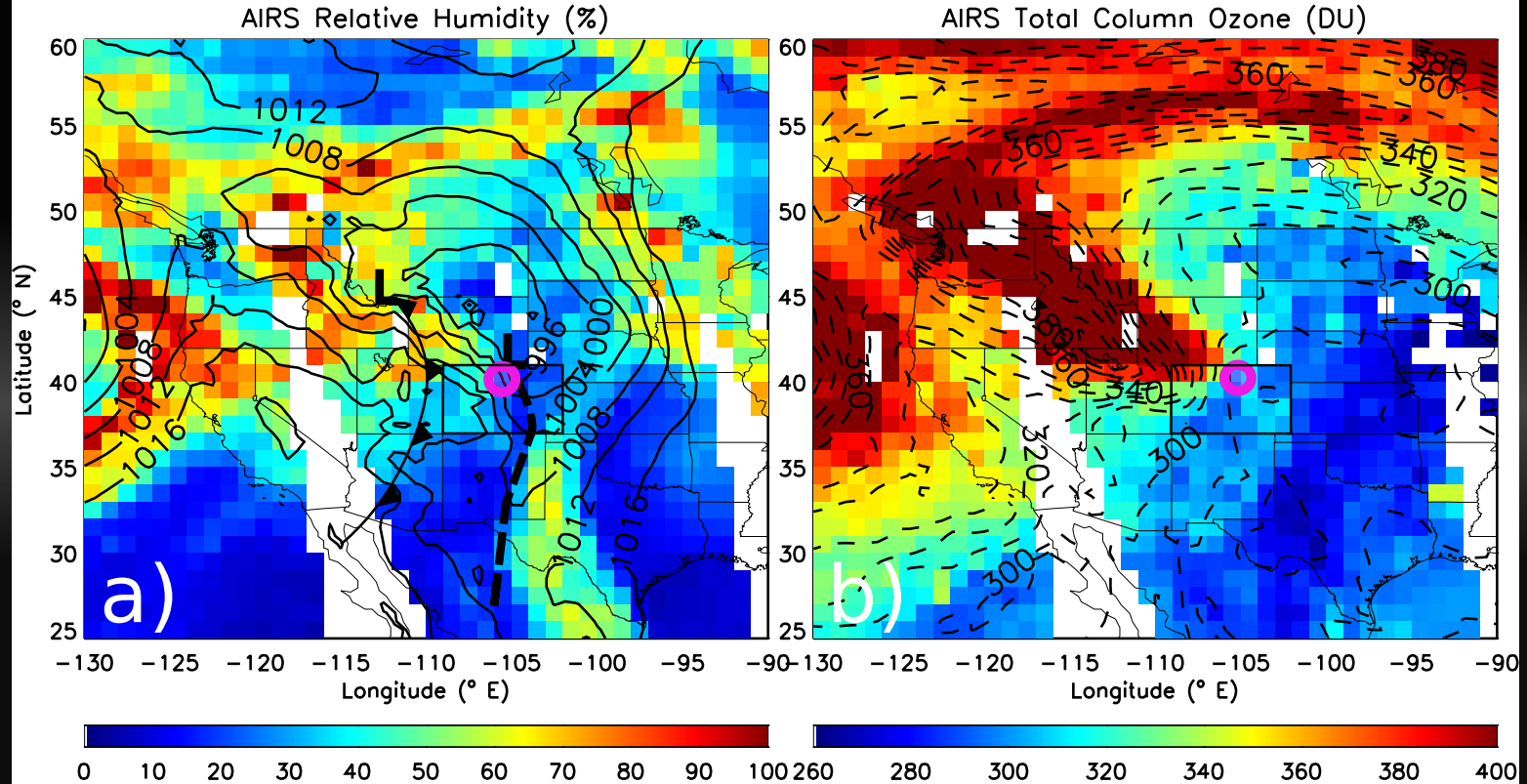
SI-1



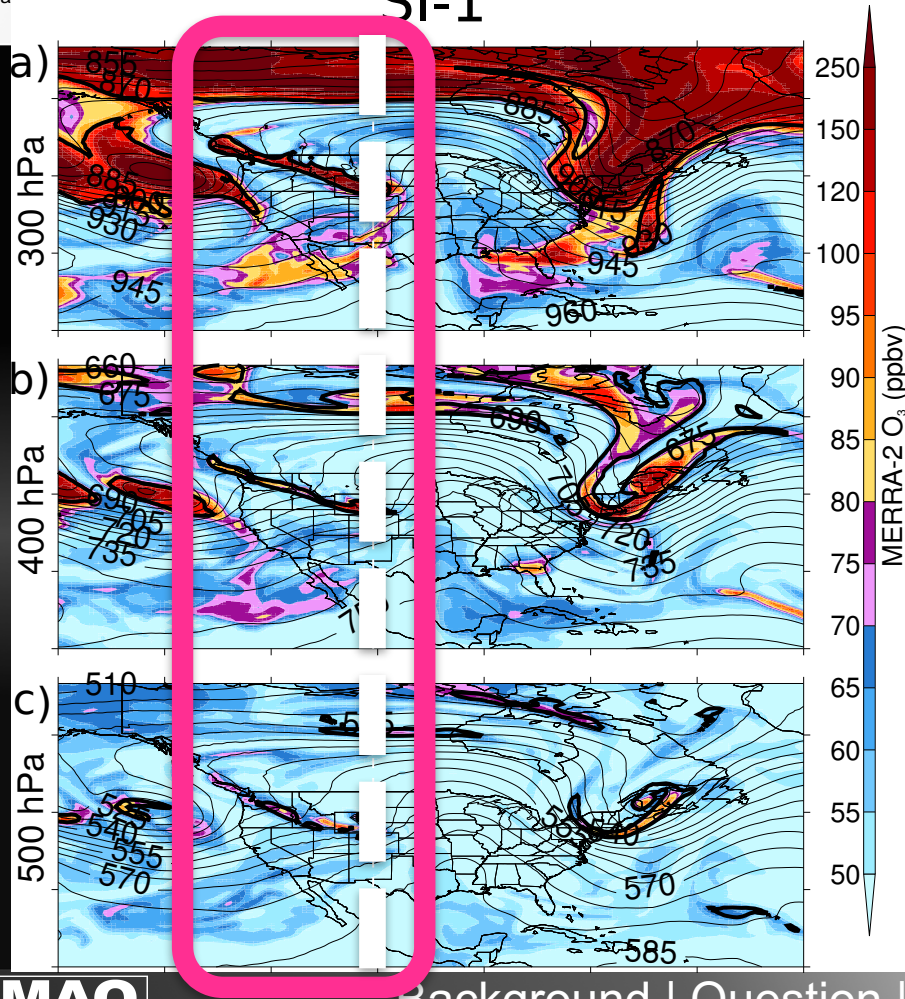
- Cold front from L in Montana
- Surface trough from L is Wyoming
- RH low behind surface trough

Knowland et al., 2017, GRL

SI-1



Knowland et al., 2017, GRL

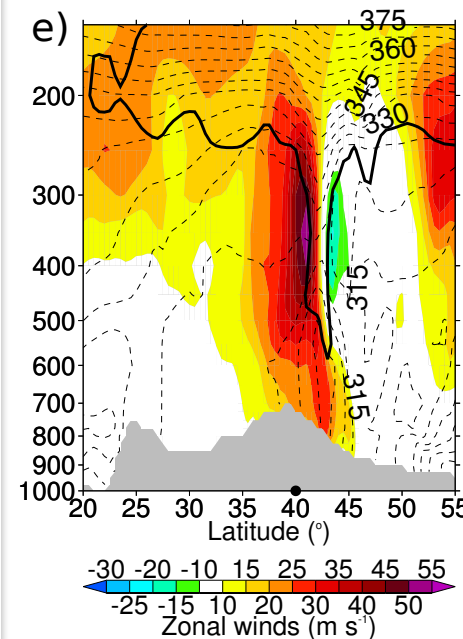


- Fine-scale filaments of stratospheric air at 300 to 500 hPa distinguish the SI-1 from background tropospheric O₃

Knowland et al., 2017, GRL

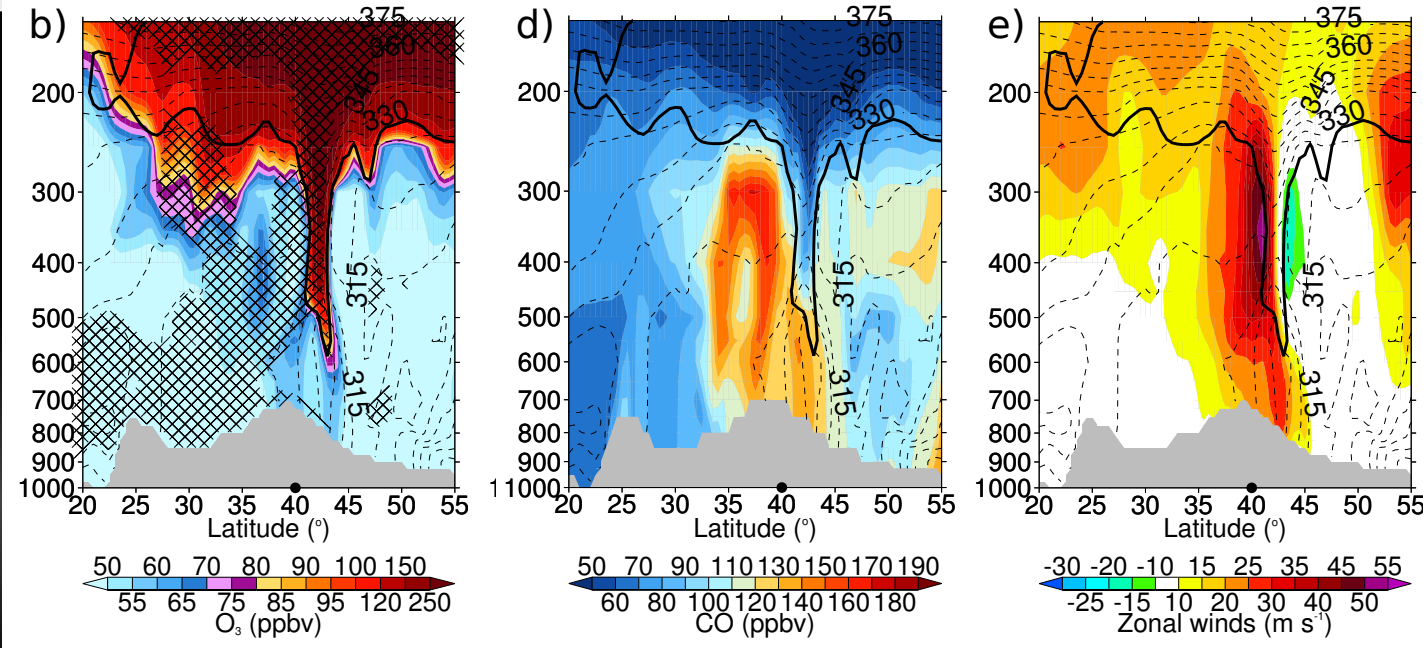
Atmospheric dynamics

- Tropopause descends to ~600 hPa
- Wrapped around jet core



- Tropopause folds are associated with:
 - High O₃, PV
 - Low RH, CO

Knowland et al., 2017, GRL



- Tropopause folds are associated with:
 - High O_3 , PV
 - Low RH, CO

Summary

- MERRA-2 is a high-resolution global reanalysis which can be used in scientific studies to identify SIs by both atmospheric dynamics and O_3
- Though MERRA-2 tends to underestimate the magnitude of surface O_3 , the combination of meteorological variables and O_3 for a long period of time to within a few weeks of present may be a valuable data set for air quality managers

Knowland, et al (2017). Stratospheric intrusion-influenced ozone air quality exceedances investigated in the NASA MERRA-2 reanalysis. GRL <https://doi.org/10.1002/2017GL074532>